Annual Review 1986-87

Alberta
ENVIRONMENTAL CENTRE

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*Front cover: a scanning electron microscope photograph of early morel mushroom (*Verpa bohemica*) spores on one of the mushroom's gills. In this shot, the spores bear a striking resemblance to cucumbers. The white rods at the base of the spores are individual bacteria. Magnification: 1,260x.*

The Alberta Environmental Centre is the province's major facility for applied environmental research, technology development and services. Officially opened in 1981, its 26,000 square metres of research facilities are located on a 300-hectare site in Vegreville, 100 km east of Edmonton. Funded through Alberta Environment, the Centre services all provincial departments and agencies which identify environmental problems requiring study. Specific projects are undertaken after review by a Technical Advisory Committee and approved by a Board of Directors. The Centre's five wings – Plant Sciences, Chemistry, Animal Sciences, Environmental Technology and Common Services – accommodate over 300 staff carrying out studies to provide new knowledge for the solution of environmental problems.

Alberta
ENVIRONMENT

Alberta Environmental Centre
Annual Review
1986-87

Alberta Environmental Centre
Vegreville, Alberta

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Contents

An Overview 5

Analytical, Diagnostic, Extension and Technical Services 7

Pest Management Research and Development 11

Water/Wastewater Management Research and Development 15

Environmental Toxicology 17

Living Natural Resources 19

Waste Management Research and Development 21

Land Resources Management Research and Development 23

Technical Support 25

Administrative Support 27

Alberta Environmental Centre Programs/Projects 29

Staff Roster 33

Staff Committee Memberships 35

Publications 37

Board of Directors 43

Technical Advisory Committee 43

1986-87 Fiscal Year Expenditures 44

Organization Chart ..... IBC

An Overview

The Alberta Environmental Centre is responsible for studying and solving environmental problems identified by Alberta government departments and agencies. From April 1, 1986, to March 31, 1987, the Centre provided applied research, technology development and environmental services in fulfillment of that mandate.

The Alberta Environmental Centre, Vegreville.

Fifteen departments and agencies called upon the expertise and facilities of the Centre, with the greatest demand coming from the Alberta Research Council; public health units; and the departments of Agriculture; Environment; Community and Occupational Health; and Forestry, Lands and Wildlife. While most activities were centred in the main laboratory building and research site in Vegreville, staff also travelled throughout the province, undertaking a broadly-defined portfolio of environmental studies in the field. Studies spanned a range of topics from biological pest control to analysis of environmental pollutants, environmental toxicology and drinking water treatment, and involved specialists in such diverse fields as veterinary medicine, botany, chemistry, microbiology, engineering and library science.

While the Centre is divided into five wings (Plant Sciences, Chemistry, Animal Sciences, Environmental Technology, and Common Services) for administrative purposes, staff continued to apply an interdisciplinary approach toward individual scientific problems. Approval and review of each research project was the responsibility of a Board of Directors and a Technical Advisory Committee of senior personnel from the main client departments.

Providing information to client agencies and the public was a significant activity during the past year Scientists from the Centre published numerous journal articles, technical reports, extension materials and books during the year. For example, a new edition of the book "Recognizing Herbicide Injury and Action" was published. A second edition of "Biological Pest Management for Interior Plantscapes" was produced, following world-wide distribution of 4,000 copies of the initial printing. A new edition of a manual for laboratory analyses of air was also produced and distributed internationally. Staff responded to several hundred requests for toxicology information, and were active in providing pest and weed management extension services to client departments and the public.

Demand for analytical and diagnostic services available through the Centre continued to be heavy. Staff conducted over 400,000 tests on more than 25,000 samples in support of provincial programs in health, pollution abatement and control, and fish and wildlife management. Specialized air, organic-compound and pesticide analysis services were provided, and a Centre staff member was appointed Provincial Analyst under the Agricultural Chemicals Act. Staff members examined another 2,500 to 3,000 specimens and samples of weeds, insects, plant diseases and chemically damaged plants at the request of farmers, gardeners and agriculture personnel. A variety of other specialized services were provided, including the analysis of isotopes for environmental investigations, identification of

microorganisms, and a rapid toxicity-testing service using bacteria.

Researchers were active in areas which promise to contribute to environmental protection and rehabilitation. For example, the Centre's inhalation toxicology facility, the only industrial-scale research centre of its kind in western Canada and one of only three in the country, conducted major research on hydrogen sulphide, a potentially dangerous byproduct of Alberta's petrochemical industry. Chitosan, a biologically-created chemical, was produced by microbiological fermentation and showed promise for various waste treatment processes. Staff solved a seed germination problem with native shrubs and progressed in the selection of native grass species, both for possible use in reclamation of disturbed sites. Some progress was recorded in the establishment of insects for control of specific weeds in Alberta, and Centre staff played a key role in determining the incidence of blackleg of canola, a serious new plant disease in the province. Researchers completed a study of the environmental effects of cattle feedlot runoff. Studies continued on water treatment processes to control giardiasis ("beaver fever"), and the results were presented at an international conference organized, in part, by the Centre.

In the area of new technology, the Centre continued development of its state-of-the-art waste incineration research capability. The Centre was also a leading player in a multi-agency, international research program on technology for solidifying and stabilizing wastes, which involved Environment Canada, the U.S. Environmental Protection Agency and private industry. A number of inventions and processes stemming from research at the Centre were patented. Alberta Technology, Research and Telecommunications is involved in finding commercial applications for this technology and in patenting other exploitable technology developed at the Centre.

A number of site and facility development projects were undertaken during the year, most notably a start on construction of a new research greenhouse unit. Commissioning of the inhalation toxicology containment laboratory was completed, and work continued on the incineration research unit. An 800 square-foot quality control/quality assurance laboratory was completed. Wetlands on the Centre site were reclaimed, with the assistance of Ducks Unlimited and the provincial Fish and Wildlife division's "Buck for Wildlife" program, to provide better water storage and waterfowl nesting areas.

Two Centre scientists visited China on a scientific exchange program, and two Chinese scientists were also stationed at the Centre. One resulting project was a study involving the use of waste straw and aspen wood to develop an exotic mushroom industry in Alberta.

Work at the Centre can be classified in nine different program areas, each representing a broad field of activity:

- Analytical, Diagnostic, Extension and Technical Services
- Pest Management Research and Development
- Water/Wastewater Research and Development
- Environmental Toxicology
- Living Natural Resources
- Waste Management Research and Development
- Land Resources Management Research and Development
- Technical Support
- Administrative Support

Analytical, Diagnostic, Extension and Technical Services

Researchers at the Centre performed a quarter of a million analytical tests for government agencies during the year.

Providing environmental services, both to client departments and directly to the public, was the largest single activity of the Centre. This program area gave Alberta Environment data needed on air, water, and wastewater quality for monitoring, licensing and enforcement programs. Information on the quality of drinking water throughout the province was delivered to public health units and other authorities, while agriculturists received diagnostic and extension services in weed science and crop protection.

Analytical Services

A total of 17,457 water samples were submitted, including samples for drinking water analysis, pollution monitoring and water quality investigations. As shown below, the

	Samples	Analytical Determinations
Health Units	7,795	116,000
Pollution Control Division	5,814	109,700
Alberta Environmental Centre	3,409	13,000
Others	439	4,700
Total	17,457	243,400

major users were public health units requiring drinking water quality tests and Alberta Environment's Pollution Control Division, which used the results to monitor and enforce environmental acts and regulations.

Drinking water tests are used by health units to ensure the water quality of new wells and other private water supplies is adequate. Information provided to the Pollution Control Division included data for the monitoring of municipal water supplies, municipal waste treatment facilities, industrial waste discharges and surface water quality objectives.

Water, effluents, soil, sediment and other materials were analysed for trace levels of organic contaminants, again mainly to provide information to Alberta Environment's Pollution Control Division and provincial health units, but also to the Centre and other clients. A total of 1,115 samples involving 43,407 parameters were analysed for polychlorinated biphenyls (PCB's), hydrocarbons and priority pollutants. A breakdown of client submissions follows.

These services were used to monitor water treatment plants which serve about half the population of Alberta. As well, various industrial samples were analysed as part of a survey of Alberta's river basins. Analytical support was provided to ensure the safe containment of hazardous chemicals at storage sites within the province, and hydrocarbon analyses were carried out in cases of spills or groundwater contamination.

Client	Samples
Health Units	85
Pollution Control Division	925
Alberta Environmental Centre	55
Other	25
Organic Contaminant Research	25
Total	1,115

Staff participated in acid rain-related research and provided analytical services to Alberta Environment's acid rain monitoring programs, involving analysis of approximately 200 precipitation samples for 3,000 parameters. Staff also adapted existing laboratory methods for these studies. Three inter-laboratory studies were conducted as part of the Long-Range Transport of Atmospheric Pollutants (LRTAP) program. Thirty precipitation samples were analysed for 480 parameters in these studies.

Development work continued on methods for detecting and measuring residues of organic compounds in the environment.

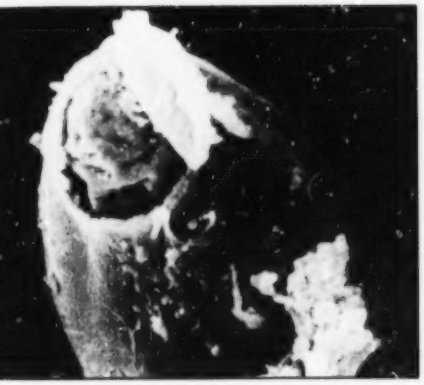
A major air analysis services program was undertaken, providing data to Alberta Environment for air quality monitoring, licensing and enforcement programs. Approximately 7,800 ambient air and stack samples were analysed for around 22,600 parameters. For example, air samples collected from all over Alberta were tested for lead and other metals, sulphur gases, nitrogen oxides, vinyl chloride and other substances. Staff were also active in adapting, updating, and developing sampling and laboratory analysis methods for atmospheric pollutants, and developing a quality control manual for sampling and analysis. Concentrations of gases near the Centre's incineration research facility were monitored, and staff presented papers on vinyl chloride monitoring, sampling and analysis at scientific meetings.

Pest Management

The Centre is Alberta Agriculture's Regional Crops Laboratory for northeast and north central Alberta. A broad series of insect, plant disease

and weed identification and advisory services were offered in accordance with that role in 1986-87. A province-wide service was provided for the diagnosis of chemical damage to plants, a program unique in western Canada. Pest diagnostic submissions handled in 1986/87 were 626 insects, 893 plant diseases and 339 weeds. In addition, 442 submissions comprised of 1,043 plant, soil and water specimens were processed in cases of suspected chemical damage to plants.

In addition to providing pest control and chemical damage information, Centre staff gave talks to farmers, homeowners, students and the general public, and produced information sheets and publications on pest management. Displays were prepared and set up at weed fairs, trade fairs and field days, and staff participated in the deliberations of national and international pest management advisory and scientific agencies.



An early morel mushroom spore bursting out of its spore sack. Magnification: 8,000x.

Animal Sciences

Animal sciences technical services were provided to client departments, other agencies and the public. A large number of telephone requests for information on veterinary toxicology were answered, particularly related to mycotoxins in grain, agricultural chemicals, and oil and gas field problems. Reports were written on studies of toxin-producing fungi in overwintered grain. Wildlife biology staff assisted a client department in reviewing grizzly bear management in Alberta and with the capture of caribou. Chemical analysis services were provided for internal toxicology studies, and a book entitled "The Changing Environment" was published.

Microbiology

Microbiological services offered to users inside and outside the centre included microbiological identification and enumeration services which examined 311 samples for 10,941 parameters, and 435 samples for 1,243 parameters, respectively. Specific jobs undertaken in these areas included monitoring of the Centre's air handling system, and developmental work on the enumeration and identification of fish and plant disease bacteria.

The Centre offered a toxicity testing service using bacteria as test organisms. Work also continued on the development of a battery of bacterial tests as a rapid means of toxicity testing, focusing on the use of the bacterium *Pseudomonas fluorescens*. An inter-laboratory study was designed and conducted, involving 18 laboratories in a comparison of a toxicity test using bacteria that emit light.

Microbiologists also carried out studies on using microbial processes and systems in waste management. Analysis was completed on a study of the microbiological effects in waters which receive runoff from cattle feedlots. Experiments were completed on the effects of chromium spills on soils, and into microbiological removal of chromium from activated sludges.

Isotopes

An environmental isotopes analysis service using naturally-occurring tritium and radiocarbon was offered. This service is unique in western Canada. These isotopes were used to determine the age and rate of change of environments. Services were provided to seven government agencies in more than 30 project areas. Work with the Alberta Research Council and the Department of Agriculture was mainly in hydrology-related studies, including soil salinity, wastewater management, drainage patterns and aquifer contamination. Services to Alberta Forestry, Lands and Wildlife and Alberta Culture were mainly concerned with wilderness areas in the province, and ancient climates and cultures, including extensive work at the Head Smashed-In Buffalo Jump Site. Erosional studies on Dinosaur

Provincial Park were conducted for Alberta Parks and Recreation.

Electron Microscopy

Electron microscope examinations undertaken in support of Centre investigations included scrutinizing over 850 samples and printing more than 4,000 micrographs. Bacteria and viruses were routinely analysed for diagnostic purposes while water filters, filter membranes, fly ash and asbestos were examined for particulate identification. Animal and fungal tissues, pollen grains and seed coats were among the other materials scrutinized. Electron microscopy staff collaborated in research projects such as waste solidification, and water treatment for *Giardia* cyst removal and inactivation.

Quality Assurance/Quality Control

Considerable effort went into ensuring the reliability of analytical results at the Centre. To carry out quality control and assurance functions, a quality control laboratory was completed during the year, and a benchmark report was prepared. Staff worked with client agencies to improve the reliability of environmental samples sent to the Centre. For example, discussions were held with provincial Fish and Wildlife staff about procedures for the analysis of fish samples taken for enforcement purposes.

Pest Management Research and Development

Practical solutions to pest and weed control require painstaking research. Here, a worker separates wild buckwheat from canola by hand at a test plot.

The Centre conducted agriculture- and environment-related research in the broad areas of weed science, entomology and plant pathology. Staff conducted analyses and research into the chemical detection and identification of pesticides. The goals of this work were to provide information to agricultural producers and others, to help them control pests in an environmentally sound manner.

Herbicides and Weed Management

Weed science research included a major program aimed at developing information on the environmentally safe use of herbicides for weed management. Field, growth chamber and laboratory studies were carried out on the effectiveness, behaviour and fate of herbicides in plants and soils, and their effect on crops. The information was made available to agencies which register herbicides and those which make recommendations to farmers.

Trials to evaluate herbicides included examining the performance of experimental and registered herbicides for weed control in cereal and canola crops, and the tolerance of varieties of wheat, barley and canola to the herbicides.

Staff completed a number of field and growth chamber studies to assess the effects of environmental factors such as weather on herbicide performance. For example, growth chamber studies showed that soil moisture had a significant influence on the performance of eight herbicides used to control grassy and broadleaved

weeds. Staff investigated the persistence of the herbicides Glean® and Ally® in soil and evaluated the use of activated charcoal to neutralize herbicide residues. Studies were undertaken into methods of detecting herbicide residues in soil.

Weed Biology and Ecology

Another major area of research was determining the economic impact of crop losses due to weeds, and studying the biology and ecology of important weeds so they can be managed effectively. Twenty-five field trials were conducted into the effect of competition from selected weeds on cereal and oilseeds crops, the extent of crop losses due to weeds, and the costs and benefits of weed control with herbicides. Development continued of mathematical models for predicting crop losses due to weeds, including preliminary work on models for canola losses due to volunteer cereal grains. Information on quackgrass and volunteer barley in canola was presented at scientific meetings.

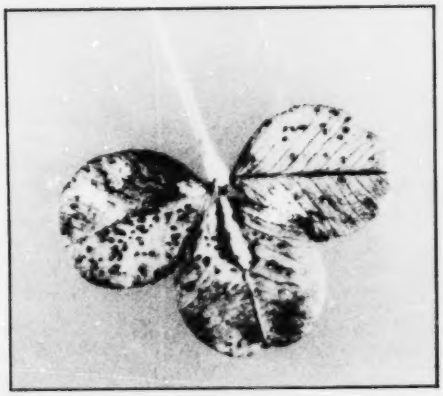
Weed biology studies were conducted in the laboratory and in growth chambers, concentrating on the life cycle of scentless chamomile, corn spurry and round-leaved mallow. The scientific literature on biological control of aquatic weeds was reviewed and a proposal made to investigate novel weed control methods in irrigation canals.

Biological Weed Control

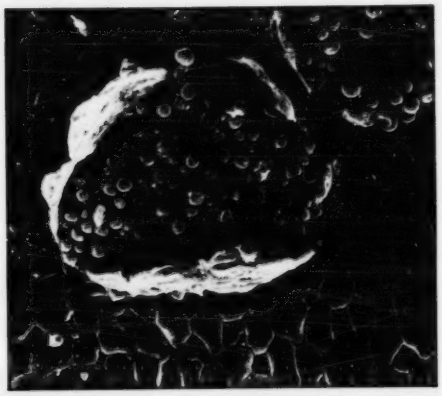
Biological weed control studies focused on the use of insects and plant disease as alternatives or supplements to other methods of weed control. Research ranged from identification of potential target weeds and biocontrol agents to the screening, release and field monitoring of the control organisms. A draft report identified the most feasible target weeds for biological control in Alberta with toad flax was named as the highest priority weed.

The Commonwealth Institute of Biological Control in Switzerland was under contract to the Centre to identify and screen European insects with potential for biological control of weeds in this province, notably leafy spurge and Canada Thistle.

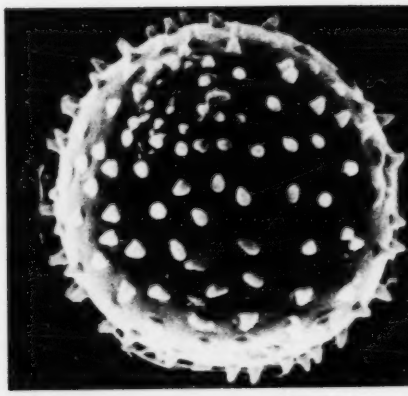
An active program of release and monitoring was maintained for species which passed screening processes, both in Switzerland and by Agriculture Canada researchers in Regina. Three leafy spurge flea beetle species released near Cardston were observed to be established. Two were increasing rapidly and causing some stress on the weeds. Two of these species were released near Hardisty and the other was re-distributed to two new sites. In



The white spots on the right-hand leaf of this clover shoot are caused by white clover rust, a common disease in the crop.



Clover rust spores on the surface of a clover leaf as they look under a scanning electron microscope. Magnification: 315x.



A single clover rust spore, isolated by the electron microscope, resembles a spiny Nerf ball. Magnification: 5,700x.

addition, a stem-boring beetle was released at Medicine Hat, and a gall midge was established and is increasing rapidly on perennial sow thistle at Vegreville. A defoliating moth was observed to have survived and bred following a release on toadflax near Mannville.

In co-operation with Alberta Agriculture a "weed disease-watch" program was initiated to identify naturally-occurring weed diseases which show potential for development into biological control agents. Studies were undertaken to isolate the disease-causing fungi and assess their effectiveness as agents for weed control.

Plant Diseases

The protection of field crops, ornamental plants and turf grasses in Alberta was the objective of applied research on plant disease prevention and control. The work included an evaluation of the effectiveness of new and registered disease-control chemicals, plant disease surveys and studies of forage, cereal and oilseed crop disease problems.

Field trials were completed on the chemical control of Sclerotinia stem rot of canola; root rot, smut, net blotch and scald of barley; and on root rot, smut and glume blotch of wheat. As well, a laboratory experiment was completed on the effects of seeding depth on two fungicide seed treatments for seedling blight control on two canola varieties.

Plant disease surveys revealed virulent blackleg of canola continues to spread in northeast Alberta. Fifty percent of surveyed canola fields were infested with the disease, compared with only 13 per cent two years earlier. A plan to increase farmer awareness of the disease was developed in cooperation with Alberta Agriculture field staff. As well, experiments were started to screen blackleg-tolerant cultivars and identify strains of the disease organism.

Investigations continued into the causes and control of "alfalfa decline" and other diseases of alfalfa. Field experiments were completed on the influence of soil-borne fungi on alfalfa growth, and on the effect of soil microorganisms on verticillium wilt of alfalfa and their potential for biological control of forage diseases. Studies were also undertaken into the influence of snow mold and brown root rot on cold hardiness of alfalfa.

Insect Pests

Applied studies were conducted into the chemical, biological and integrated control of crop and livestock insect pests in Alberta.

Field studies were completed on the control and impact of flea beetles and root maggots in cabbage crops, and root maggots in rutabaga crops. Research continued on a native species of predatory mite used for biological control of western flower thrips in greenhouses, and on the use of combined chemical and biological control of pests in greenhouse vegetable crops.

Field crop work included an assessment of the migration, development, impact and control of lygus bugs in canola. Monitoring of bertha armyworms and various cutworms was completed as part of a province-wide pheremone trap monitoring program.

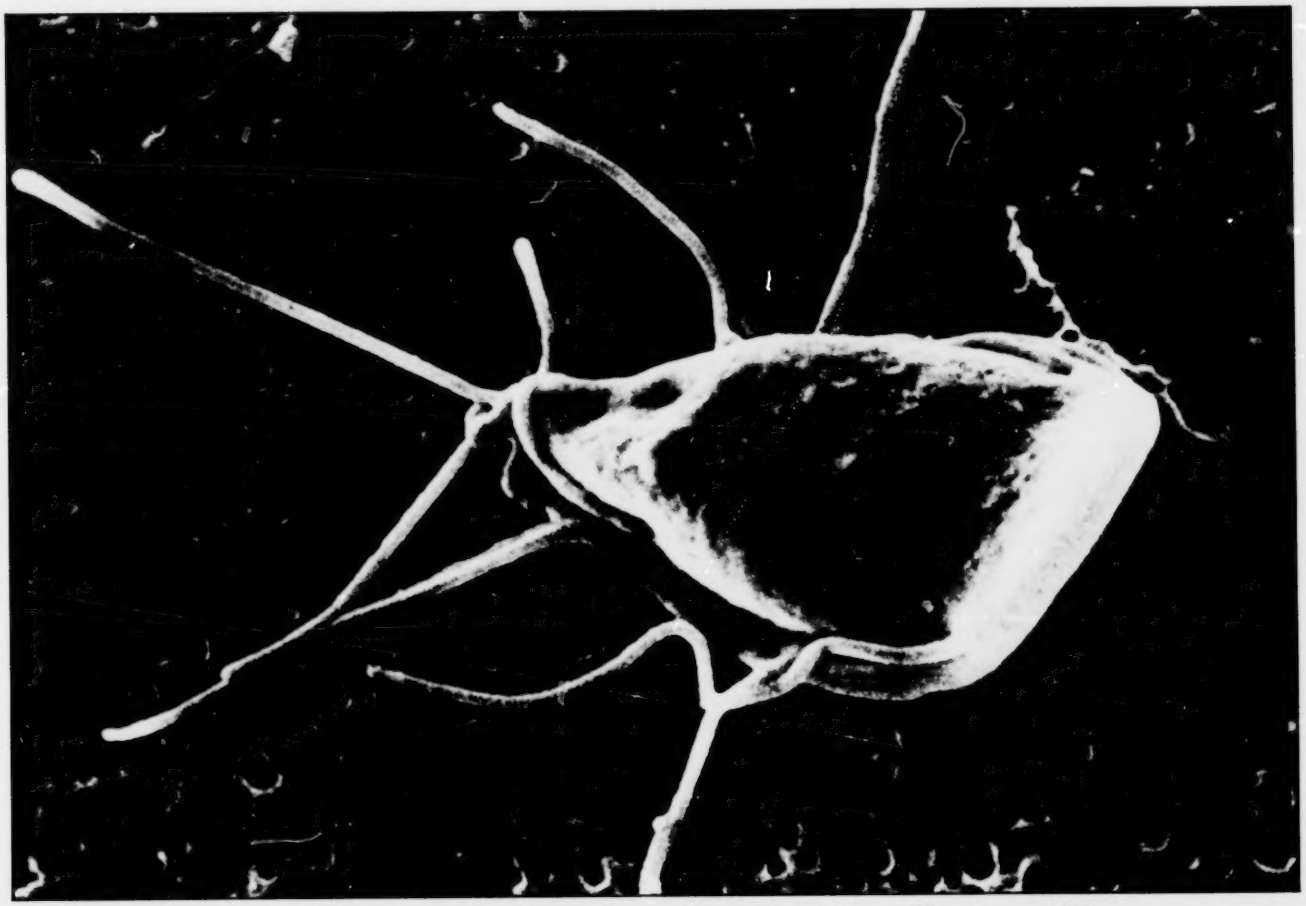
The second year of research was completed in a three-year study on protection of cattle from black flies (a particular problem in the Athabasca area) and other biting flies, using novel on-farm control methods. As well, staff performed studies on the potential use of a parasite to control house flies in hog barns, and on the influence of insecticide-impregnated ear tags for biting-fly control on the growth of nursing beef calves.

Research reports were completed on the prevalence of swine mange in Alberta, the effect of pesticide residues on cattle, and the control of flea beetles and root maggots in vegetable crops.

Pesticide Analysis

Pesticides were analysed in water, soil, sediment and other materials, and work continued on the development of laboratory methods of detecting and identifying pesticide residues. A total of 1,878 samples involving 47,272 parameters were examined. Water was tested for pesticide residues in support of Alberta Environment and provincial health unit monitoring programs, Sediment and water samples were tested as a part of such programs as black fly control studies, grasshopper control activities and pesticide container collection. Soil, foliage and water samples were analysed on behalf of the Centre's plant chemical damage investigation service.

Water/Wastewater Management Research and Development



A trophozoite of Giardia muris, *an intestinal pest which causes giardiasis or "beaver fever" in humans. Magnification: 9,500x.*

Work in this area was aimed at developing the technology and information required to assure adequate supplies of high quality water. Research was carried out to assess the status of environmentally-significant chemicals in water and to develop technology for the treatment of particular water quality problems.

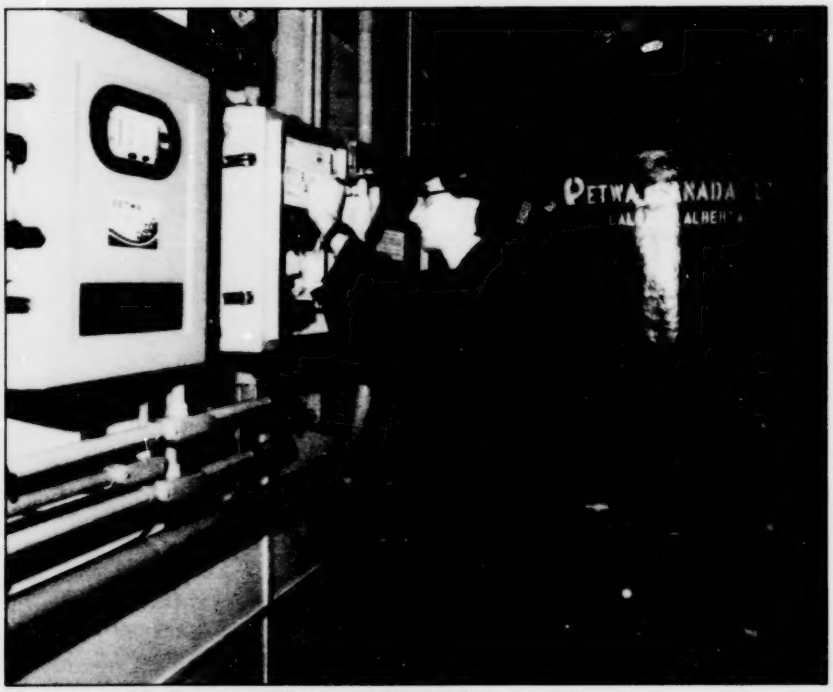
Several projects were undertaken to improve the quality and quantity of drinking water supplies in Alberta. Among these was a major initiative to evaluate current and alternative technology to remove or inactivate *Giardia* cysts. *Giardia* are the cause of "beaver fever". A mobile water treatment trailer with 200 litre-per-minute capacity was used in the project undertaken jointly with the University of Calgary. During the summer of 1986 two treatment processes, disinfection and filtration, were tested for control of the cysts. The Centre was also involved in organizing and staging an international conference on *Giardia*.

Staff continued work on a long-standing program to determine the distribution and concentration of environmentally-significant chemical residues in the province. In continuing efforts to monitor mercury levels in fish, over 700 fish tissues from 31 lakes and rivers in Alberta were analysed. In addition, a report was completed on an earlier study of mercury residues in fish from 24 Alberta lakes and rivers, and a manuscript on the geochemistry of

mercury was being prepared.

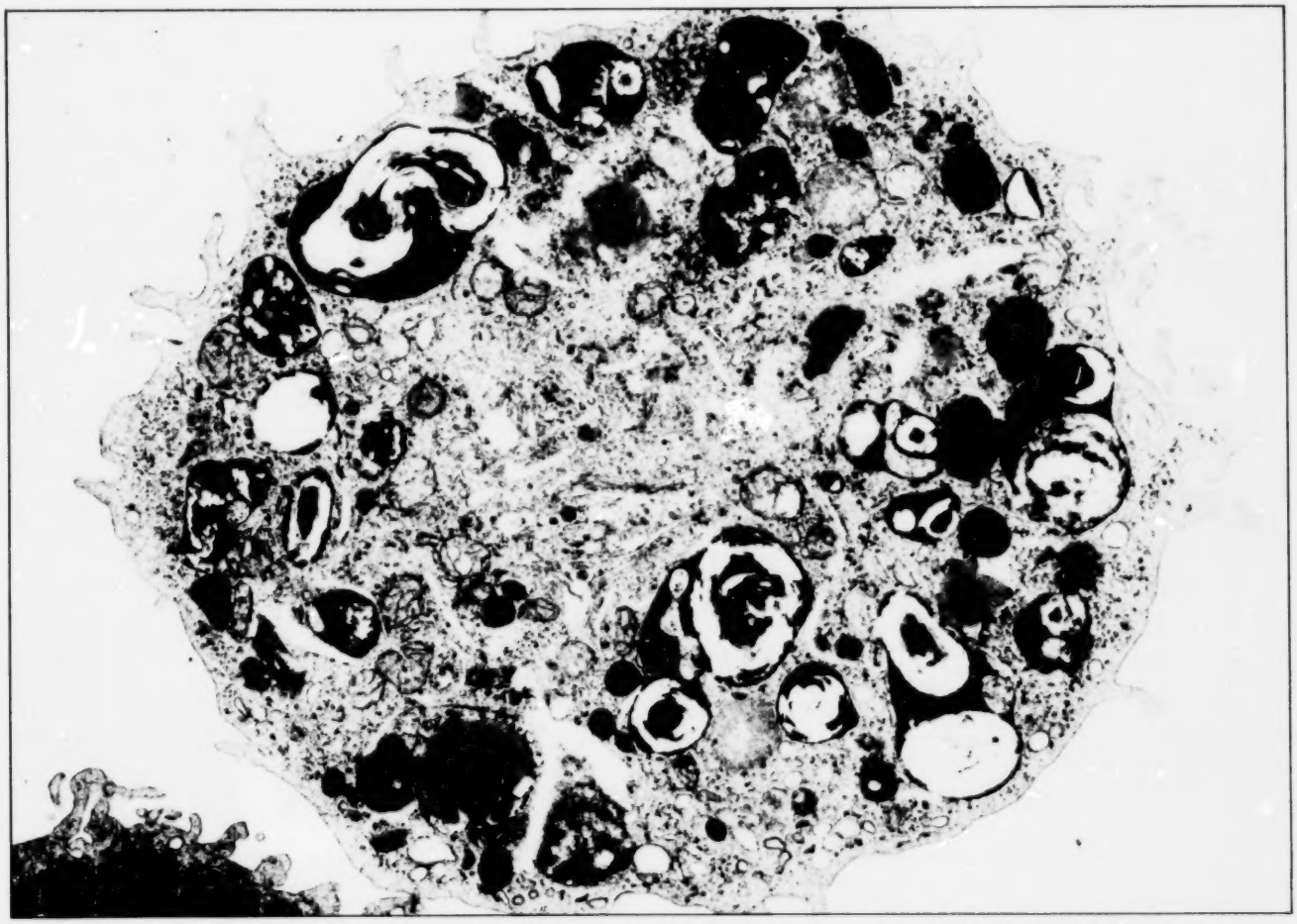
Preservation and rehabilitation of the rare peregrine falcon were the objectives of a program to monitor chemical residues in the falcons and their prey in the Fort Chipewyan area. Work continued on data previously collected at falcon release sites in southern Alberta. A report was also prepared on chemical residues in the fat and eggs of colonial nesting birds.

Determining the effects of wastewaters on natural water systems was the objective of a number of aquatic toxicology studies . Reports were prepared on the chemistry and toxicity of alum sludge, coal mine waste water and flocculants, and kraft pulp and paper mill effluent ingested by rats. A number of new laboratory techniques were developed to study blood changes in fish exposed to effluents.



The interior of the Centre's mobile water treatment plant.

Environmental Toxicology



This picture of a macrophage (one of the body's trash collectors) from the lung of a rat was taken by a transmitting electron microscope. Magnification: 10,950x.

Research focused on the potentially harmful consequences of chemicals or agents of either natural or human origin. The studies centred on agricultural and industrial pollutants, and their effects on animals ranging from fish to humans.

A high priority was placed on inhalation studies to determine the toxic effects of gases, vapors, particulates and aerosols on living organisms. Client departments requested a focus on potential health effects on people and livestock. Work concentrated on the effects of hydrogen sulphide.

The inhalation studies were centred in the new inhalation toxicology containment facility which was commissioned during the year. Research methods were developed to study the effects in rats of hydrogen sulphide on reproduction and the effects of sulphur compounds on cells and on enzyme activity. As well, plans were drawn up for studies of the chronic effects of exposure to hydrogen sulphide.

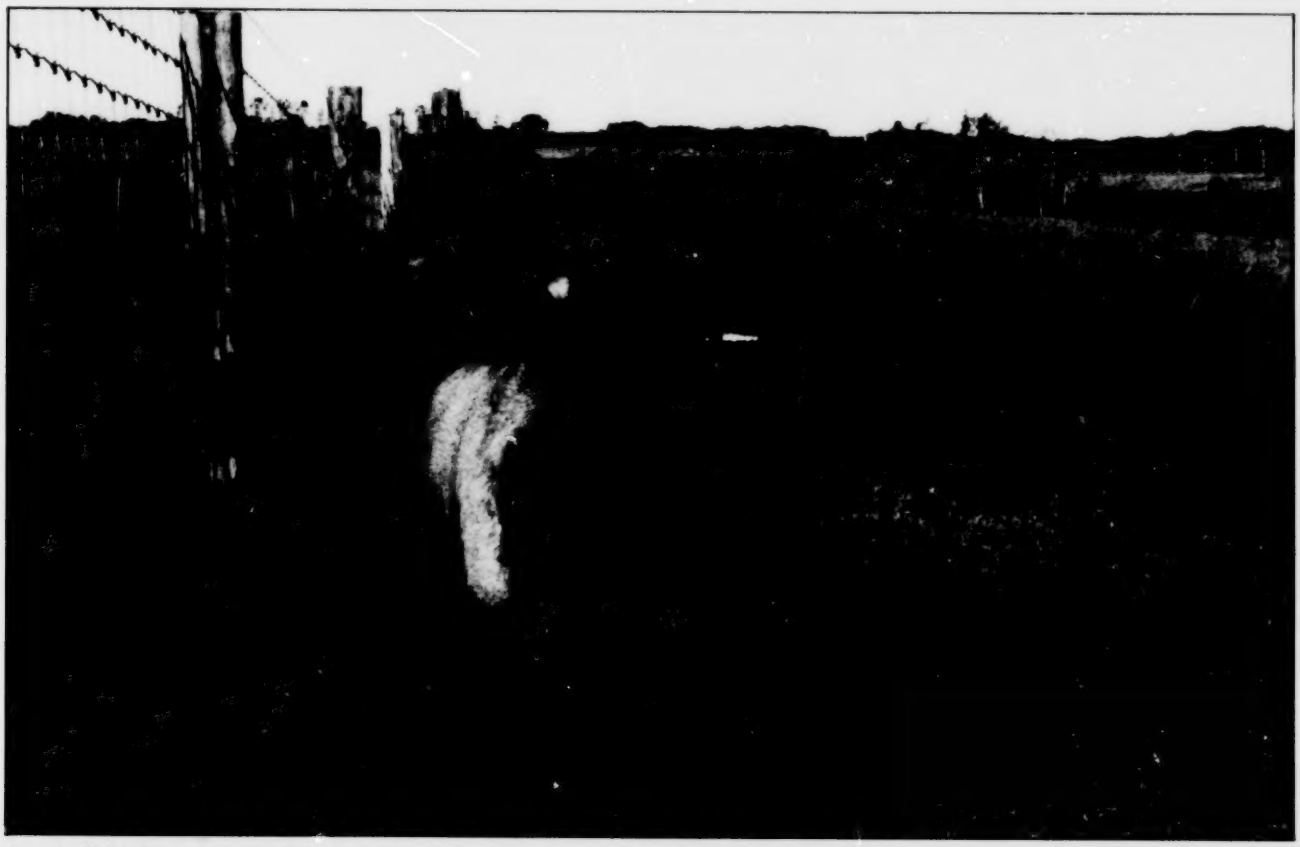
As the result of an interdisciplinary research project between the Water Analysis group and investigators from the University of Alberta's pharmacology department, sulphide levels in the brain tissues of rats were measured for the first time. This observation should open many

avenues for further investigation.

Staff participated in studies on the toxicology of petrochemicals and fossil fuels, particularly to livestock and fish. These projects concentrated on crude oils, heavy oils, drilling fluids and other petrochemicals. Tests were developed and trials were carried out to assess the biochemical effects of crude oil ingestion on laboratory animals and the resulting pathological changes in liver, kidney and other tissues.

Researchers completed a report on the toxicity to fish of bitumen which seeps naturally into the Athabasca River in the oil sands region. A related study was completed on the uptake of certain hydrocarbons by fish.

Living Natural Resources



A male elk (his horns trimmed) hisses a warning to a photographer who ventured too close to his territory.

Studies in this area concentrated on gaining an understanding of the physical, chemical and biological changes which may affect Alberta's living natural resources: its fish and wildlife.

In one project, population characteristics and mercury concentrations in fish in the Dickson reservoir were monitored by creek surveys and netting. Data such as species dominance, age, sex, diet and size were recorded.

Analysis continued on information collected during five years of study on the effects of forestry operations on bears in the Berland Timber Management Area. The data was obtained in studies which included the capture of over 50 grizzly and black bears and surveillance of 38 bears equipped with radio collars.

Using toxic collars on sheep to control coyote predation and testing poisons for pocket gopher control were the subjects of other studies. The collars were placed on lambs to test their potential as an effective, highly specific method of controlling problem coyotes. Audio tape-players were also examined as a means of luring problem coyotes to lambs wearing the toxic collars. Work on pocket gopher control was aimed at reducing damage to forage crops by the animals. Studies were undertaken to insure that poisons mixed with glue would stick to the gophers' fur and then be ingested during grooming.

Staff examined the impact of pesticides on non-target species, emphasizing problems of pesticide accumulation, effects on host animals for the target species and solution of

specific field problems. A major project was conducted on the environmental consequences of grasshopper control activities. Eight studies on the effects of insecticides on game birds, and a pilot study on gulls, were completed.

other game species interact with their environments. The field phase was completed on a study into the seasonal variations in the nutritional quality of forages used for elk pasture.

The design, development and testing

A researcher in the Centre's pilot study on the effects of pesticides on gulls has lots of company in this part of a field study.

Considerable research was directed toward increasing the province's wildlife resources by gathering information needed for intensive game production, in co-operation with the Kikino Game Ranch near Lac La Biche. Staff completed a resource inventory of the ranch, providing a basis for the management of the operation. Development continued on a system for monitoring animals to provide information on how elk and

of practical systems for the humane trapping of furbearing animals was another major research project, conducted under an agreement with the Fur Institute of Canada. It emphasized the optimization of Conibear and Kania traps for the humane harvest of mink and marten. A trap was developed which satisfied all criteria and which appears to have been successful in field trials by trappers.

Waste Management Research and Development

Centre researchers have been trying to find new ways to deal with waste products. Sawdust was used to grow these exotic edible mushrooms (known as "yu-hang" to the Chinese, or yellow top mushrooms in North America). Holding them up for inspection is exchange scientist Jason Lu.

Major technology development and research projects were undertaken to assess and develop waste management processes with potential application in Alberta. Physical, chemical and biological techniques for waste management were examined.

Development began on a system for studying the incineration of wastes and the operation and design of incinerators. A pilot-scale incinerator was installed in the new incineration research building. Staff worked on emission monitoring and scrubbing systems to ready the facility for test burning of wastes. Another, smaller-scale system for studying waste incineration was also installed in the new building, modified, and used in preliminary testing of wastes.

Staff continued research on methods for solidifying and stabilizing wastes. A cooperative project was undertaken with Environment Canada, the U.S. Environmental Protection Agency, and the private sector to assess the suitability of selected solidification processes for waste management in Alberta. The focus was on developing methods of testing how well the processes stabilized wastes. In particular, researchers were interested in how the solidified wastes stood up to Alberta's severe climate. For example, methods for determining permeability and resistance to weathering were examined. Electron microscope examinations of solidified wastes were performed and staff also

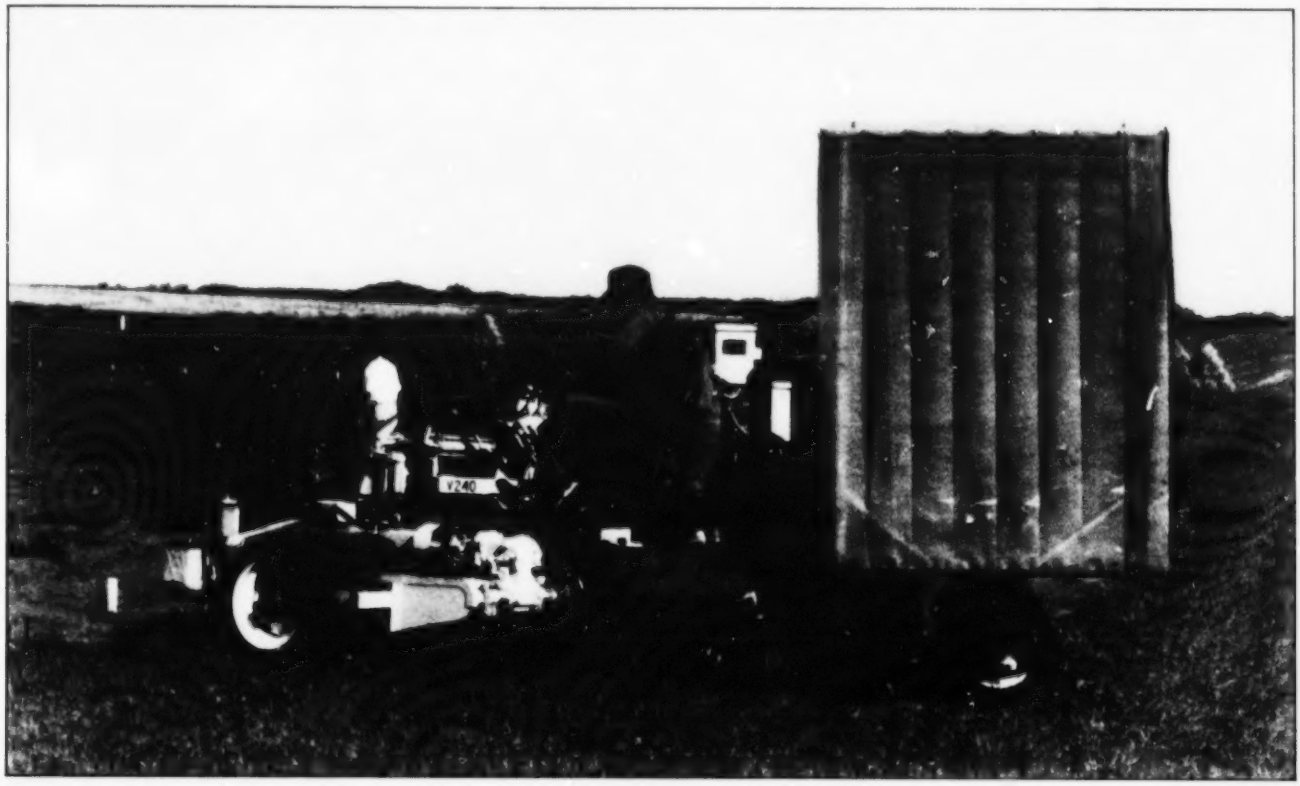
worked with industry to evaluate waste solidification and stabilization processes in the field.

Researchers investigated the use and production of chitosan, a naturally-occurring chemical which can be used for flocculation (removing suspended particles from water), heavy metal absorption and other waste treatment processes. The chemical was produced by fermentation and studies were undertaken to optimize its production. Preliminary tests were carried out on the use of chitosan to absorb heavy metals in wastes. The Department of Technology, Research and Telecommunications expressed interest in the product and initiated a market study for chitosan.

The use of sawdust, straw and other cellulose-based wastes for cultivation of exotic mushrooms was examined. This project was undertaken as part of an Alberta-China science exchange program in which the Centre is hosting a scientist from Harbin, China. The objective is to determine if Oriental mushrooms and mushroom cultivation techniques can be used in Alberta, utilizing local waste materials such as straw and aspen wood.

Ettringite crystals (calcium sulphoaluminates) trapped in cement solidified waste. Magnification: 2,750x.

Land Resources Management Research and Development



Seeding test strips to grow plants with a high potential for reclamation purposes is carried out by Centre personnel with a specially-designed seed drill.

Soil science and revegetation research was carried out to provide information needed for restoring disturbed lands such as strip mines to productivity.

In the soil science area, projects were undertaken to develop and test ways to speed reclamation, lower its cost and ensure the original quality of disturbed land surfaces is restored.

Four soil projects were directed toward soils with excess soluble salts or sodium. In laboratory and greenhouse trials, it was shown that a soil's physical properties which govern water movement and storage are directly responsible for poor plant growth in it. Further research in this area aims at relating a soil's composition to plant performance so it will be possible to predict how well soils can be reclaimed.

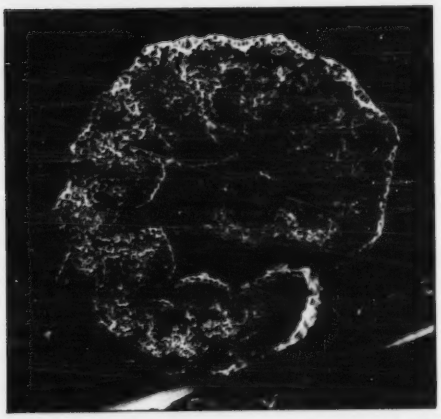
Studies were undertaken on the use of cropping systems to control salt movement in soils. Two large field experiments evaluated the use of deep-rooted plants to change the physical properties of soils, controlling soil salinity and the upward movement of sodium. Related studies were undertaken into the rate of sodium release from the weathering of bedrock and its implications for reclamation.

Problems of soil compaction, particularily on oil and gas leases, were investigated, leading to the development of a reliable measure of compaction which relates directly to the capacity of a plant's roots to penetrate the soil. The next stage is to investigate methods of correcting compaction problems.

Promising results were obtained in studies into the use of selected plant species to remove water from oilsand tailings ponds.

Native Species

A major program was aimed at selecting, developing, testing and licensing suitable lines of native plant species for use in reclaiming disturbed lands.

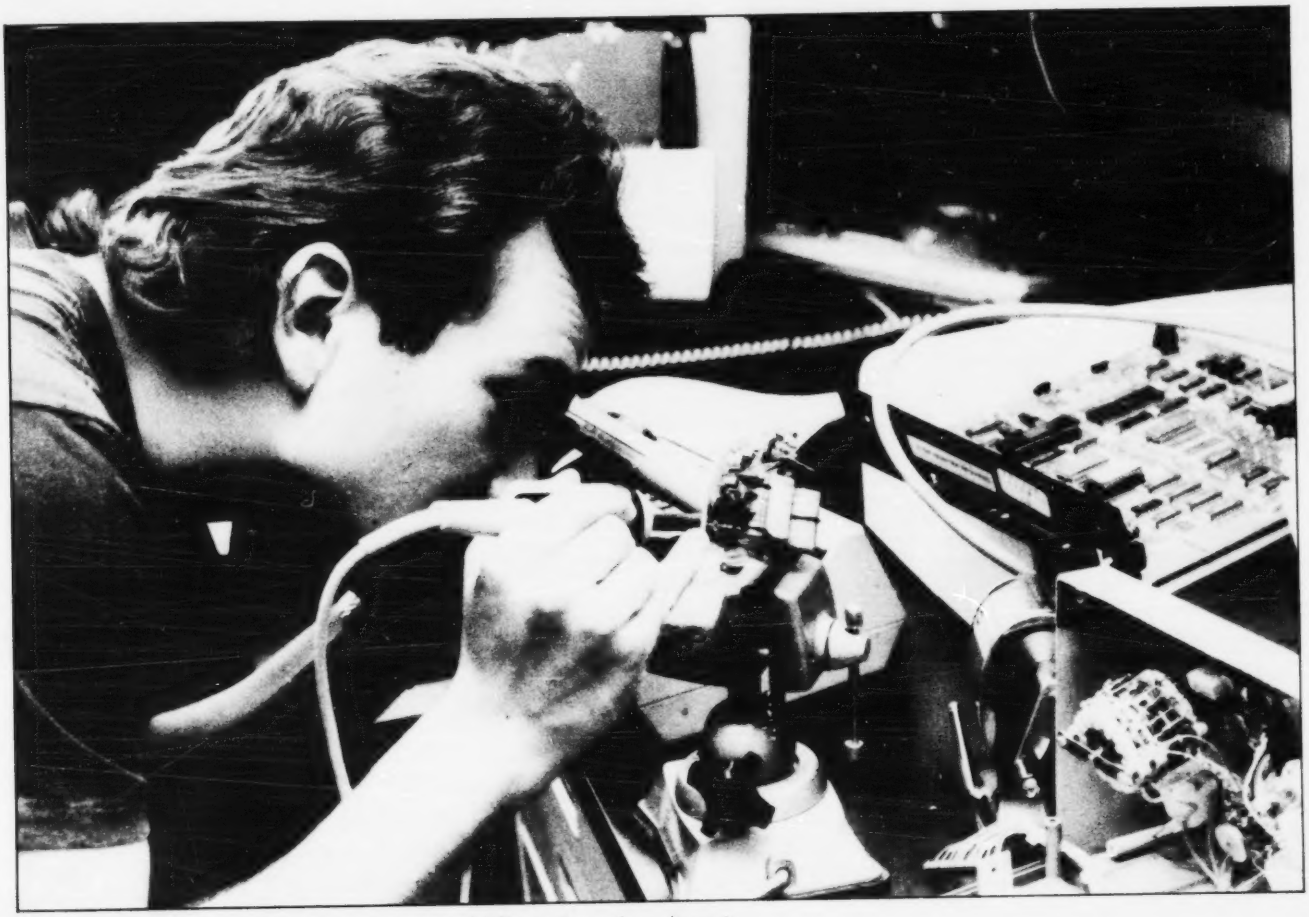


This cross-section of a grass stem (magnified 1,250 times) helps scientists at the Centre determine the best plants to use for rangeland rehabilitation.

Initially, work concentrated on finding native species for reclaiming disturbed lands in the high-altitude eastern slopes of the Rockies. Native grasses with potential for high altitude reclamation were gathered in an extensive program in 1985. These species were evaluated to identify lines which appear to have the characteristics required for east slope reclamation and selections were made in 1986 for further study. Other lines were found to have potential for superior biomass production and were chosen to develop a grass variety for use in rangeland rehabilitation and improvement in east slope agricultural areas.

As well, native plant seed lines were maintained for possible future work on reclamation in southern Alberta, and a final report was prepared on the propagation of native shrubs for oil sands reclamation.

Technical Support



Technicians at the Centre maintain a wide variety of delicate electronic equipment.

Work in this area covered everything from providing specialized growing environments for experimental plants, to maintaining scientific instruments and equipment and developing computer software for research projects.

Thirty-six plant growth chambers were operated and maintained, allowing researchers to gather information prior to field studies and to conduct experiments year-round under rigidly controlled environmental conditions.

A pathology services program provided support to toxicology and wildlife studies at the Centre, including the analysis of changes in tissues and fluids of animals under study.

A high standard of care was provided to experimental animals acquired for research purposes. An Institutional Animal Care Committee was active in ensuring that animals were handled according to accepted principles of humane care. The committee functioned as the local arm of the Canadian Council on Animal Care, a national organization concerned with the humane treatment of laboratory animals.

Computer and instrumentation services which were provided to the Centre included services and facilities for research computing and instrumentation. A major effort was directed toward the development of a system linking laboratory instruments to the mainframe computer. Initial work concentrated on developing and modifying programs required for computer capture of chemical analysis data. In-house programming for a chemistry prototype project was completed and demonstrated, and commercially developed software was evaluated. As well, computer access to government and university computing facilities was upgraded and work started on the computerization of plant sciences diagnostic services.

As well as providing electronic repairs, instrumentation staff developed instruments and systems to monitor and control processes and experiments. For example, a voice recognition system was implemented at an in-house water treatment plant, allowing plant operators to be informed of alarms and to obtain information by telephone. Staff also assisted with field trials of a telemetry system for wildlife research, and developed a room pressure monitoring system for the inhalation toxicology building. Other projects included developing a system for conducting water taste tests, and an instrument for measuring the mass, diameter and length of plant root systems through computer-aided analysis.

Site support personnel oversaw operations on the site, such as weed and insect control on non-research areas, and provided support for research activities. Their activities included putting up hay and bedding for elk and cattle, maintaining research plot areas and emergency snow removal. They undertook development projects such as the fencing of elk pastures and also maintained and co-ordinated a large fleet of equipment and vehicles.

Administrative Support

The Centre's emergency response team performs a first aid drill for the camera.

Work in this area was aimed at providing efficient support to the Centre's scientific and technical projects. Administrative services ranged from secretarial and clerical support to the operation of a technical library and central warehouse and stores facility. Services were provided by the Common Services Wing as well as by smaller administrative units attached to each of the four technical wings.

In the Plant Sciences Wing, a major effort was directed toward facility upgrading and expansion. Four laboratory bays for soils and vegetation studies were planned and commissioned, and equipment was acquired for the laboratories. Plans were drawn up to finish additional laboratory space required for weed science and vegetation studies, and to develop a field lab, seed storage and drying rooms and a plot equipment storage facility. Work also progressed on automating the handling of research data and on office automation. Construction began on a major research greenhouse facility.

A statistician in the Animal Sciences Wing provided consulting services on experimental design, data analysis and quality control to the

entire Centre and directly participated in research projects.

The administrative services provided to 60 Animal Sciences Wing staff included the processing of more than 6,000 documents. Staff handled budget monitoring and forecasting tasks, continued development of a word processing system and restructured research programs. In the area of capital facilities development, commissioning of the inhalation toxicology laboratory was completed, working drawings for a radiography (X-ray) suite were completed, and planning for a cattle feedlot started.

Administration of the Environmental Technology Wing included technical as well as administrative functions. The technical responsilities included providing environmental engineering services intended to minimize any impact of the Centre on the site and surrounding area. Laboratory wastewater was monitored and treated while concentrated laboratory wastes and pesticide wastes were collected and shipped out for disposal. In addition, other specialized water treatment facilities were operated. Engineering services were offered to Centre programs such as the humane trapping and sludge dewatering studies. Staff also provided the budgeting, secretarial and electrical assistance, planning and management required for wing programs.

Chemistry Wing staff provided administrative and office support services for 57 permanent staff. A heavy administrative load included the processing and distribution of more than 30,000 chemical analysis reports. Staff handled purchasing and converted purchasing records from a manual to a computer basis. New computer software was used to develop stock, wage, and expenditure reports. Wing administrative and purchasing manuals were completed.

The Common Services Wing acted as the central administrative unit for the institution, providing a wide variety of informational, financial and personnel-related services.

A major financial function was the preparation, administration and monitoring of the Centre's $11.6 million annual budget. Expenditure reporting was automated, and a new inventory control system implemented. Staff also developed an assets and contract registry, and related purchasing, stock and financial services were provided.

The library continued to be a key element in research projects, providing information through manual and computer-assisted reference searches, continuing to develop a balanced collection of reference material, and similar services. A total of 97 in-depth, on-line computer searches were performed and 3,773 inter-library loans were processed.

Recruitment, staff relations, payroll and training services were provided by Personnel Services Section staff. In addition, the occupational health program provided 30 job-related courses and maintained an emergency response team.

Information about Centre activities was provided through the development of an informational display, newsletters and an annual review, the staging of a field and display day, and participation in the Vegreville Fair. An employee handbook and a lapel pin were produced.

Alberta Environmental Centre

Program/Project Lists 1986/87

Program	Project/ Sub-Project	Client Agency
Administration and Research Support Services	Program Development	Environment
	Research Planning and Management	Alberta Environmental Centre (AEC)
	Administrative Services	
	Biometrics Services	
	Staff Training and Development	
	Safety	
	Quality Assurance/Good Lab. Practice	
Air Analytical Services	Health Units	Environment
	Pollution Control Division	AEC
	Standards and Approvals Division	Community and Occupational Health
	AEC	
	Others	
Animal Resources	Program Development	Environment
	Laboratory Animal Acquisition and Maintenance	AEC
	Livestock Acquisition and Maintenance	
	Aquatic Animal Acquisition and Maintenance	
	Wildlife Animal Acquisition and Maintenance	
Aquatic Toxicology	Program Development	Forestry, Lands and Wildlife
	Toxicity Evaluation of Industrial Wastewaters	Environment
		AEC
	Toxicity Evaluation of Municipal Wastewaters	
Biological Control of Weeds	Priority List of Weeds	Agriculture
	Survey of Arthropods	
	Biology and Host-specificity	
	Capital Facilities Development	
	Animal Care Committee	
	Release and Monitoring	
	Post-establishment Studies	
	Surveys of Plant Pathogens	
Biology and Ecology	Biology of Weeds of Alberta	Agriculture
	Weed-Crop Competition	
	Weed Surveys	
	Taxonomy of Weeds of Alberta	
	Biology and Control of Aquatic Weeds	
	Special Assignments	
Computer and Instrumentation Services	Repair and Maintenance of Laboratory Systems	AEC
	Engineering and Systems Design	
	Research Computing Development	
	Research Computing Operation	
Chemical Residues	Program Development	Forestry, Lands and Wildlife
	Geochemistry of Mercury in Southern Alberta	Environment
		AEC
	Mercury Residues in Fish	
	Speciation of Heavy Metals	
	Chemical Residues in Colonial Nesting Birds	
	Chemical Residues in Peregrine Falcons	
Controlled Environment	Growth Chambers and Greenhouses	AEC

Ecological Studies	Program Development Aquatic Habitat Studies Forestry Development and Wildlife Resources Problem Wildlife Research Wildlife Productivity	Environment Forestry, Lands and Wildlife Agriculture
Electron Microscopy	Health Units Pollution Control Division Other	Community and Occupational Health Agriculture Alberta Research Council Environment AEC
Environmental Isotopes	Development of Methods and Systems Radiation Liaison Services C-14 & H-3 Environmental Research and Applications	Agriculture Alberta Research Council Culture Forestry, Lands and Wildlife Environment
Herbicides and Weed Management	Performance Evaluation of Herbicides Crop Safety and Tolerance to Herbicides Behavior and Fate of Herbicides in Plants Behavior and Fate of Herbicides in Soil Chemical Damage Diagnostic Techniques Environmental Factors and Performance of Herbicides Research Appraisal and Planning (Expert Committee on Weeds)	Environment AEC
Humane Trapping	Program Development Mechanical Killing Devices for Small Furbearers Field Testing Power Snare Evaluation	Forestry, Lands and Wildlife Agriculture Fur Institute of Canada
Inhalation Toxicology	Program Development Inhalation Toxicology Systems Development Chronic Effect of Sulphur Gases Reproductive Effects of Sulphur Gases Biochemical Effects of Sulphur Gases	Community and Occupational Health Environment Agriculture
Insect Pest Management	Special Crops Insect Pest Management Field Crops Insect Pest Management Livestock Insect Pest Management	Agriculture
Microbiological Services	Microbiological Enumeration Microbiological Identification Services Microbial Toxicity Service Microbiological Processes in Waste Management	Agriculture Environment AEC
Native Species	Native Species for Reclamation – East Slopes Native Species for Reclamation – Northern Alberta Native Species for Reclamation – Southern Alberta	Energy Environment
Pathology Services	Program Development Necropsy Service Histopathology Service Clinical Pathology Service Ultrastructural Pathology Service	AEC

Pest Management Diagnostic and Extension Services	Insect Diagnostic and Extension Services Plant Disease Diagnostic and Extension Services Weed Diagnostic and Extension Services Chemical Damage Diagnostic and Extension Services	Agriculture Community and Occupational Health Environment AEC
Pesticide Analysis and Methods Development	Health Units AEC Pollution Control Division Interdisciplinary AEC Other Interdisciplinary Pesticide Research	Community and Occupational Health Forestry, Lands and Wildlife Agriculture Environment
Plant Pathology	Disease Management in Cereal, Oilseed and Special Crops Disease Management in Forage Crops Disease Management in Woody Ornamentals, Shelterbelts, and Turf	Agriculture Environment
Potable Water Technology	Treatability of Surface Waters Subject to Effluents from Pulp Mills Giardia Cyst Removal and Inactivation Groundwater Treatment Mobile Water Treatment Plant Camrose Water Problem	Public Works Supply and Services Environment Agriculture Community and Occupational Health
Precipitation Studies	Pollution Control Division Long Range Transport (LRTAP) Research Management Division Others	Environment AEC
Quality Improvement, Statistical Analysis and Data Management	AEC Quality Control Alberta Environment Quality Control External Quality Control Statistics and Research Design Data Management	Community and Occupational Health Forestry, Lands and Wildlife Environment AEC
Site Administrative	AEC Site Development Services Site Equipment Services Site Operation Services Site Research Support Site Vehicle Services	Site Support Services
Soil Reclamation Research	Sodic Spoil Behavior Water Use & Salt Transport Water Balance: Sodic Soils Soil Compaction Sodic Spoil Ion Release Biological Dewatering Inventions and Methods	Agriculture Energy Environment AEC
Technical Services (Animal Sciences)	Program Development Analytical Toxicology Toxicology Services Aquatic Biology Services Wildlife Biology Services	Agriculture Forestry, Lands and Wildlife Environment AEC
Toxicology of Biocides	Program Development Toxicology of Methoxychlor Toxicology of Insecticides on Livestock Environmental Effects of Grasshopper Control Activities	Agriculture Forestry, Lands and Wildlife Environment

Toxicology of Petrochemicals and Fossil Fuels	Program Development Toxicology of Petroleum Hydrocarbons in Fish Toxicity of Tar Sand Holding Pond Effluent Toxicity of Crude Petroleum to Livestock Toxicity of Petrochemicals Experimental Toxicity of Crude Petroleum	Agriculture Energy Environment
Trace Organic Analysis and Methods Development	Health Units Pollution Control Division Other	Community and Occupational Health Forestry, Lands and Wildlife Environment AEC
Waste Management	Incineration Fixation Fermentation Cellulosic Waste Utilization	Agriculture Environment Hospitals and Medical Care Special Waste Management Corporation Technology, Research and Communications
Water Analytical	Health Units Pollution Control Division Alberta Environmental Centre Others	Community and Occupational Health Recreation & Parks Environment Forestry, Lands and Wildlife

Staff Roster
(At March 31, 1987)

Executive Director:
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Baynish Bassett, B.A. (Saskatchewan)
James Bloor, B.A. (Keele)
Jim Bradley, B.Sc. (Alberta)
Michael Casselman, Ph.D. (Dalhousie)
Fran Henry, RN
Herb King, B.Comm. (Alberta)
Diana Lee, MLS (Alberta)
Gerry Lofthaug, B.Sc. (Alberta)
Mary Meers, RN
James "Scotty" Miller, M.S. (Alaska)
Robin McDaniel, Ph.D. (Alberta)
Vera Raschke, M.L.S. (Alberta)

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Chin Chu, M.Sc. (Alberta)
Reinhard Hermesh, M.Sc. (Saskatchewan)
Sheau-Fang Hwang, Ph.D. (Washington State)
Richard Johnson, M.Sc. (Saskatchewan)
Kent Kerby, Ph.D. (Alberta)
Prem Kharbanda, Ph.D. (Illinois)
Douglas Linman, B.Sc. (Alberta)
Donald Lobay, B.Sc. (Alberta)
Alexander McClay, Ph.D. (Cambridge)
John O'Donovan, Ph.D. (Cork)
Hugh Philip, M.Sc. (Alberta)
Fayyaz Qureshi, Ph.D. (London)
Paul Sharma, Ph.D. (Alberta)
Marilyn Steiner, B.Sc. (Bath)
Don Thacker, M.Sc. (Queen's)
Heidy Tilsner, Ph.D. (British Columbia)
Rina Varma, Ph.D. (Alberta)
Paul Yeung, M.Sc. (Alberta)

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Professional Staff:
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Henry Bertram, B.Sc. (Alberta)
Richard Coleman, Ph.D. (Alberta)
Nirmal Das, Ph.D. (Ottawa)
Fred Dieken, Ph.D. (Victoria)
Lydia Goatcher, Ph.D. (Maryland)
Lorne Goodwin, B.Sc. (British Columbia)
Krishna Gupta, M.Sc. (Aligarh)
Magdi Habib, Ph.D. (McGill)
John Headley, Ph.D. (Warwick)
Yogesh Kumar, Ph.D. (New Brunswick)
Maria Neuwirth, Ph.D. (Toronto)
Ansar Qureshi, Ph.D. (New Brunswick)
Dean Smillie, Ph.D. (British Columbia)

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Professional Staff:

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Steve Cook, B.Eng. (McMaster)
Robert Coppock, D.V.M. (Michigan State), Ph.D. (Illinois)
Alexander Hawley, Ph.D. (Saskatchewan)
Thomas Heming, Ph.D. (British Columbia)
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Philip Oltmann, Ph.D. (Dalhousie)
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Subramaniam Ramamoorthy, Ph.D., D.Sc. (Madras)
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Lou Wei, Research Associate

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Georges Dagenais, M.Sc. (Alberta)
Stephen Davies, Ph.D. (Western Ontario)
Leslie Dowdell, M.Sc. (Simon Fraser)
David Dugle, Ph.D. (Alberta)
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Paul Layte, M.Sc. (Cranfield)
Albert Liem, Ph.D. (McMaster)
Jason Lu, B.Sc. (Harbin Normal University)
Richard Milner, B.Sc. (Alberta)
Bhaskaran Pandompatam, Ph.D. (Concordia)
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Albert van Roodselaar, Ph.D, (Alberta)

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Barb Dreger; Connie Gizowski; Debra Skorienko

Public Works Supplies and Services Property Management Division

SUPERINTENDENT: Marshal Palichuk

Andy Ambrock; Joe Charchun; John Chester; Peter Clement; Bill Czar; Jean Dussome; Lindsay Edwards; C. Freed; Paul Godziuk; Don Henderson; Dave Kindrachuk; Berna Kirechuk; John Kirechuk; Lawrence Koncur; Henry Kostyniuk; Keith Kreamer; Craig Murphy; Gordon Rennie; Peter Rubuliak; Ed Rudyk; Harry Sawchuk; Bill Skoreiko; Rob Stuart; Bill Towpich; Brad Tymchuk; Walter Tymchuk; Marshall Weremy; Roy Winder; Doug Yakemchuk; Jim Zuk

Staff Committee Memberships

Alberta Agrometeorology Advisory Committee
Alberta Aquatic Plant Management Committee
Alberta Biotechnology Committee
Alberta Black Fly Control Steering Committee
Alberta Cereal and Oilseed Advisory Committee
Alberta Climate Advisory Committee
Alberta Environmental Centre, Board of Directors
Alberta Environment Executive Committee
Alberta Environment Technology and Research Advisory Committee
Alberta Environmental Centre, Technical Advisory Committee
Alberta Forage Advisory Committee
Alberta Government Libraries Council
Alberta Government Libraries Council. Reference Services Special Interest Group.
Alberta Government Technology and Research Advisory Committee
Alberta Horticulture Extension and Advisory Committee
Alberta Laboratory Association
Alberta Pest Control Advisory Committee
Alberta Warble Control Advisory Committee
Alberta Water Analysis Committee
Alberta Weed Advisory Committee
Alberta Weed Advisory Committee – Research Subcommittee
Alberta Weed Advisory Committee – Extension Subcommittee
American Public Health Association, Standard Methods Committee Member for Microbiological Task Group
American Society for Testing and Materials, Microbiological Methods Committee
Applied Aquatic Studies Workshop – Organizing Committee
Biophysical Program Planning Committee – Research Management Division
Canadian Association of Veterinary Pathologists
Canadian Council of Research and Environment Ministers Working Committee
Canadian Council of Resource and Environment Ministers Working Group on Dioxins
Canadian Pest Management Society – Executive Committee
Comparative Respiratory Society
Departmental Committee for Acid Deposition
Energy Resources Conservation Board
Entomological Society of Canada, Scientific Committee for Report on the Economics of Insect Control on Wheat, Corn and Canola in Canada
Environmental Contaminants – Program Planning Committee
Expert Committee on Weeds (Western Canada) – Research Appraisal and Planning Committee
Expert Committee on Weeds (Western Canada) – Biological Control of Weeds Subcommittee
Expert Committee on Weeds (Western Canada) – Monsanto Scholarship Committee

Industrial Vegetation Management Association of Alberta – Reclamation Committee
Institute for Research on Public Policy, Council of Trustees
Interdepartmental Working Group on Analytical Services
International Standards Organization, Microbiological Methods Subcommittee
Lakeland College, Conservation and Reclamation Advisory Committee
Oilsands Reclamation Committee
Prairie Provinces Water Board, Task Force on Water Quality Analytical Methodology
Program Planning Committee
Reclamation Research Technical Advisory Committee
Research Review and Analysis Committee
Research and Development Subcommittee of Industrial Vegetation Management Society of Alberta
Soil Reclamation Subcommittee
Soils Subcommittee of Mountains/Foothill Reclamation Committee
Soils and Crops Subcommittee of Plains Coal Reclamation Research Committee
Toxicity Assessment, An International Quarterly Journal, Editorial Board
Weed Science Society of America, Weeds Causing Losses Committee (Special)
Weed Science Society of America, Outstanding Young Weed Scientist Subcommittee
Western Committee on Crop Pests
Western Committee on Livestock Pests
Western Committee on Plant Disease Control
Western Expert Committee on Grain Diseases

Publications

A. Refereed Journals and Publications

Albassam, M.A., J.W. Moore, and A.K. Sharma. 1987. Ultrastructural and clinicopathological studies on the toxicity of acrylamide-based flocculant to fish. *Vet. Pathol.* 24:34-43.

*Albassam, M.A., R.W. Winterfield, and H.L. Thacker. 1986. Comparison of the nephropathogenicity of four strains of infectious bronchitis virus. *Avian Diseases* 30:468-476.

*Bidani, A., T.A. Heming, C. Geers, G. Gros, and E.D. Crandall. 1986. Effects of dextran-bound inibitors on carbonic anhydrase activity in isolated rat lungs. *Am. Rev. Respir. Dis.* 133:A201.

Das, N.C., H. Bertram, and Y. Lau. 1986. Precipitation chemistry measurement in Alberta. *Water, Air & Soil Pollution Journal* 30:230-237.

Davies, J. S., J.V. Headley, F. Skinner, and M.A. Wilson. Color reduction in a leached Kraft mill effluent. *Proc. World Congress III of Chemical Engineering.* September, 1986. Tokyo, Japan.

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* As of March 31, 1986

1986 - 87 Fiscal Year Expenditures
(Thousands of Dollars)

	Manpower	Supplies and Services	Grants	Fixed Assets	Total
Common Services	1228	1277	0	33	2538
Plant Sciences	1341	205	0	64	1610
Chemistry	2182	308	0	211	2701
Animal Sciences	1654	567	0	132	2353
Environmental	1208	372	0	359	1939
Total	7613	2729	0	799	11141

Organization Chart